

A Method for Analyzing the Context of Stakeholders and their Requirements

Takako Nakatani and Yuko Koiso

Graduate School of Business Sciences, University of Tsukuba, 3-29-1, Otsukba, Bunkyo-ku, 112-0012 Tokyo, Japan

Keywords: Requirements Elicitation, Environmental Factors, Social Relations, Stakeholder Analysis.

Abstract: Requirements of software are sometimes added and changed throughout the development phases. In this paper, we introduce a method to analyze environmental factors that sometimes cause changes in requirements. The scope of the i* framework, for example, does not focus on environmental factors, but on the intentional actors and their dependencies. To date, the various environmental factors are not analyzed well. Furthermore, some of the environmental factors have relationships with stakeholders and thus change the intentions of stakeholders through these social relations. We consider these relationships as one of the providers of and a mechanism that forces changes in requirements. Before we proceed to prove the role of this mechanism through an application to a real project, we first define four social relations that connect an environmental factor and a stakeholder, and introduce an analysis method of the context. The effectiveness of the method is shown through several examples and discussed from the view of the possibility of the prediction of requirements changes.

1 INTRODUCTION

Requirements volatility produces various negative effects on the software development process: reduction of performance (Zowghi and Nurmuliani, 2002) and increase of costs to the project. Ebert and Man focused on the problems that cause requirements volatility (Ebert and D., 2005). Also, the risks involved in requirements volatility have been discussed by Williams et al (Williams et al., 2006).

Multiplies of methods have been introduced to prevent requirements changes. For example, analyzing goals to be achieved helps analysts clarify operations as requirements and conflicts between goals (van Lamsweerde, 2004; Damas et al., 2006). When we have analyzed a business in the early requirements analysis phase, we understand the world more precisely. Yu, et al. developed the i* framework to clarify dependencies among stakeholders in a strategic dependency model and analyze goals achieved by the stakeholders themselves with a strategic rationale model (Yu and Mylopoulos, 1998). Yu and his colleagues also integrated the models and a process modeling method in order to develop a business modeling technique (Yu et al., 2011). The integration leads analysts to elicit more stable requirements.

In general, the process of requirements elicitation originates from listing important stakehold-

ers. Alexander and Robertson defined an onion model (Alexander and Robertson, 2004; Robertson and Robertson, 2005). In the onion model, each stakeholder is categorized within the zones of the model. Each zone represents how each stakeholder relates to the developing product with regard to the distance between the stakeholder and the product. The onion model is effective to cover important stakeholders with whom requirements analysts interview and elicit their requirements from.

Why cannot these methods prevent requirements changes? One of the answers is that requirements are volatile; and basically, we cannot prevent them from changes. However, there may be another answer. These methods are focused on issues in the process of development, communication between users and developers, the quality of documents, personal capabilities, and so on (Bano et al., 2012). We consider that the scope of the methods may be too narrow to deal with requirements changes. This does not mean that we have to explore other stakeholders, but more precisely, analyze the context of related stakeholders (Pohl, 2010). Faily et al. defined the context as the environment of operation of users (Faily and Flechais, 2009). The context of personal requirements should be analyzed in some sort of system: learning and training applications, entertainment and games, etc. (Sutcliffe et al., 2005). It is also important

to analyze the context of business information systems where competitive advantage which is a goal of most companies and cooperation with other companies are important. If these competitive and/or cooperative relationships between companies are changed, the decisions of stakeholders must be affected. As a result, their requirements are changed. We can define the context of business information systems as being the environment of operations, and that it is not limited solely to the user, but also to business people and/or organizations. Thus, the context affects the decisions of stakeholders. When the changes in requirements caused by changes in the context of business information systems are observed, they may have been classified into missing requirements, functional enhancement, or product strategy (Nurmuliani et al., 2004).

The context consists of environmental factors (MacAulay, 1996; Sommerville and Sawyer, 1997; Kotonya and Sommerville, 1998) and relations between them and stakeholders. Candidates of environmental factors are competitors, cooperative organizations, the natural environment, etc. Though there are various factors, we regard the principles of these factors to be but a few. We have challenged ourselves to clarify the basic concepts of the environmental factors, and further, set them inside the scope of analysis in order to analyze the variability of requirements.

We term “relation” between the environmental factors and stakeholders as “social relation”, since a change caused in the environment which is the society surrounding the stakeholders, propagates to a stakeholder via the relation, and further, affects his/her intention within their various organizations. Stakeholders may not be able to control or manage such changes, but we have confidence that if analysts take into consideration the context of the decisions of stakeholders, they must be able to analyze the possible changes within the context and, predict them.

There is a method developed to analyze dependencies between stakeholders. The *i** framework (Yu and Mylopoulos, 1998) consists of two models: the strategic dependency model (SD model) and the strategic rationale model (SR model). The SD model contains dependency relations between intentional actors within the analyzing world. The intentional actors are the stakeholders of the developing system. There are four types of dependency between actors: task, resource, goal, and soft goal. The actors within the scope of the *i** framework already hold intentions in deciding the requirements of the developing system when the analysis starts. Hence, the environmental factors that affect the intentions of the actors had been set outside the scope of the *i** framework.

The purpose of this paper is to introduce an analysis method to define social relations in order to predict requirements changes. We extend the SD model to introduce social relations. In order to introduce the social relations, we adopt Fiske’s human relations (Fiske, 1992). When the method is applied in the early requirements phase, the context of stakeholders will be visualized. We expect such visualization to be effective in understanding the context of each stakeholder’s decisions and in evaluating the volatility of the context and thus, his/her requirements.

This paper is organized as follows. In section 2, we introduce the method used to analyze social relations with regard to environmental factors. In section 3, we evaluate the effectiveness of the method by applying the method to a real project and visualize the environment of the stakeholders and the mechanism of requirements changes. In the final section, we conclude this paper.

2 ANALYSIS OF THE CONTEXT

In this section, we first introduce four types of social relation by adopting Fiske’s human relations. After that, we present a process of the analysis.

2.1 Social Relations

Fiske classified human relations into four elementary forms: communal sharing, authority ranking, equality matching, and market pricing (Fiske, 1992). The forms can be interpreted as social relations: sharing relation, ranking relation, exchanging relation, and contracting relation, respectively (Nakatani and Tsumaki, 2014). In order to analyze the context of intentional actors, we extend the SD model by adding medium that causes changes in the intentions of a stakeholder and the four social relations, as propagation paths of the changes. Some examples of various media are gifts, offerings, sharing properties, strategies, rules, constraints, force, rights, etc.

The detailed definitions of social relations are as follows:

- **Sharing Relation.**
Sharing relations are relations between parties who share the common interests and/or cultures and feel that the good things for one are also good things for another. The parties are sometimes competitors or rivals.
- **Ranking Relation.**
The upper ranking parties have privileges over the lower ranking parties. Ranking is introduced into

societies such as militaries and corporations. Parties on both sides have social responsibilities.

- **Exchanging Relation.**
This type of relation guarantees interdependence and fair exchange.
- **Contracting Relation.**
Social contracts include tradition, rules, promises, etc. A party who breaks the contracts receives social punishments.

2.2 Process of the Analysis

We assume that an SD model has been presented before analysts start to apply our method. The main part of our method is to analyze four types of relations connected with the actors within the original SD model. Such a starting point will give a hint to the analysts who are the extracting parties within the context of intentional actors in the SD model. The following process is repeated until the effect of changes in environmental factors on the intentional actors is considered small enough to be ignored.

1. Focus on each intentional actor within the SD model.
2. Extract and define parties who have a social relation with the intentional actor or parties defined in the context.
If the party is already defined within the world of analysis, the relation can only be defined as one between the party and the actor.
3. Define the social relation and a medium with regard to the relation.
4. Analyze the variability of parties and media. The existence of variability implies requirements changes.

The legend of the notation is shown in Figure 1. Each social relation in the notation of the extended SD model has the first letter of each social relation. An example of the result of the analysis is shown in Figure 2. Analysts explore each social relation by providing a medium for each stakeholder.

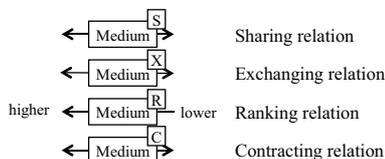


Figure 1: The legend of the extended SD model.

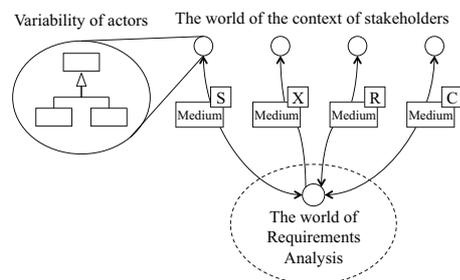


Figure 2: An example of the result of the analysis.

3 APPLICATION OF THE METHOD

In order to evaluate the effectiveness of the method, we applied it to a real project.

3.1 Overview

The project was initiated to develop a support system of the contract of a non-life insurance (NIC) system. Agents use the system on their tablet computers and input the data of their customer’s contracts digitally. The system verifies the contract data when an agent puts it into the system. After that, the policyholder candidate who is a customer of the agent agrees to the contract. The data is sent to the non-life insurance management system on the host computer and is registered. Once the contract data is registered, any policyholder can refer to his/her contract and their insurance policy via the internet.

We can draw a before and after picture of the installation of the NIC system with SD model.

3.2 The System-as-is

Before the NIC system was installed, the agents used personal terminals developed only for the contracts of insurance. The terminal could check the mandatory items in a contract and send the data to the non-life insurance management system that would verify the data formally. If there were errors in the contract data, the agent would correct the data on the physical application form under his/her customer’s agreement. After the agreement, the agent would send the physical application form to the insurance company and the corrected digital application data to the non-life insurance management system from his/her terminal. Thus, the insurance company employed people as verifiers who were in charge of the verification of contracts by comparing the content from the physical application form with the content from the digitally

registered data in the non-life insurance management system.

Figure 3 shows the situation as the system-as-is model with the i* framework. The intentional actors in the system-as-is were the insurance company, the policyholder or its candidate, the person insured, and the agents. These actors are the stakeholders of the system-to-be of the NIC system. Further, paper application forms and verifiers are shown in the figure.

Since, the system-as-is had the two kinds of data for a single contract, one in paper form, and the other in the form of registered digital data in a database, there were two parallel checking procedures in the contracting process. One was done by terminal and the non-life insurance management system, while the other was done by verifiers. If the terminal was more intelligent, contracts could be processed more simply and quicker, thus allowing a reduction in the labor cost of verifiers. In order to solve these problems, the non-life insurance company decided to develop a new system by introducing the tablet computers to the agents. The new system will be able to verify the application data and support the agents in making correct on site assessments with regard to their policyholder candidates. The stakeholders agreed to abolish the paper medium of contracts and policy certificates. The paper-less system was also a requirement of the authorities of the Japanese government. Furthermore, the company thought that the modern tablet computers might make the impression of the company better for the policyholder candidates.

3.3 The System-to-be

Figure 4 shows the situation surrounding the NIC system. After the installation of the NIC system, the paper medium that was used as an application form and a policy certificate was abolished. When the stakeholders decided to abolish the paper medium, the requirements analysis team gathered the opinions of the authorities in charge of the new system, MLINT(Ministry of Land, Infrastructure, Transport and Tourism). The policyholders hence forth would be able to review their policies of insurance at any time via the internet. Such improvements contributed to the following goals:

- Increasing sales and/or reduced labor costs.
- Improving customer satisfaction.
- Ensuring legal compliance.

The NIC system appeared to be completely adequate. We can show the adequacy of the new system, that is to say, how the system achieves the goals set forth through the utilizing of a goal model. Because of the

limited space, we do not present the goal model in this paper.

After the system was released, some agents required the company to output the policy certificate in paper form. This was an unexpected change in requirements. As shown in Figure 3 and Figure 4, the SD models could not present the necessity of the requirement. In order to solve this problem, we had to extend the scope of the analysis.

Here, we apply the extended SD model to re-analyze the problem domain. We will discuss the results in the next subsection.

3.4 Applying the Extended SD Model

Figure 5 represents the context of requirements realized in the requirements elicitation phase within the extended SD model. The dotted circle is the boundary of the original SD model of the i* framework. The original SD model is extended through the inclusion of the social relations between an actor within the SD model and the context of the actor. The Ministry of Land, Infrastructure, Transport and Tourism (MLIT) notified its branches to accept digital policies of insurances. According to the notification, general contractors can submit copies of insurance policies that are submitted by subcontractors. The MLIT even accepts screen shots of the digital policies of insurance. Following this, the MLIT starts management matter examinations of the general contractor. This was the reason that the non-life insurance company decided to abolish the paper medium of policy certificates. The colored resources in the figure are the parts corresponding to the change in requirements.

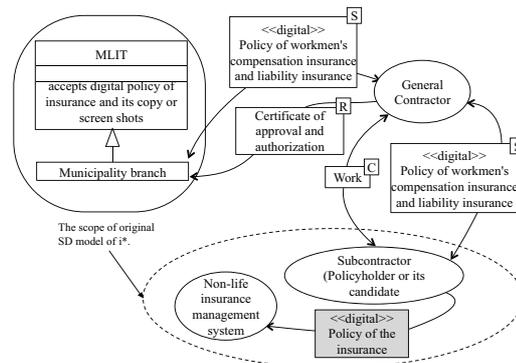


Figure 5: The context of requirements realized within the requirements elicitation phase.

Figure 6 represents the context of stakeholders by taking the requirements changes into account. Actually, there were some branches that did not follow the notification of the MLIT. These branches did not accept the screen shots of the digitalized insurance

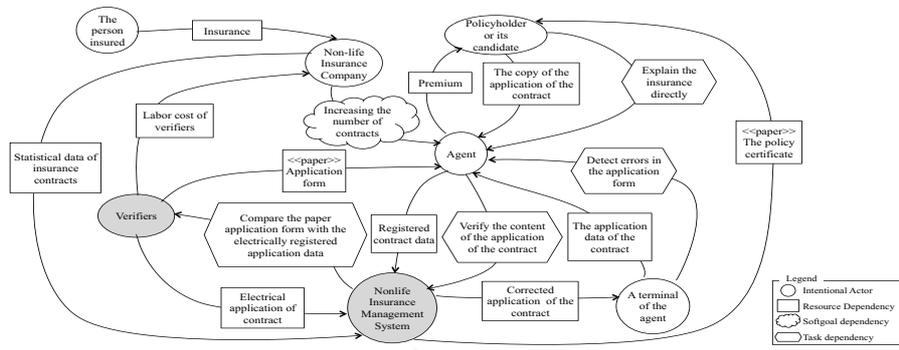


Figure 3: An SD model of the as-is context of a contract of non-life Insurance.

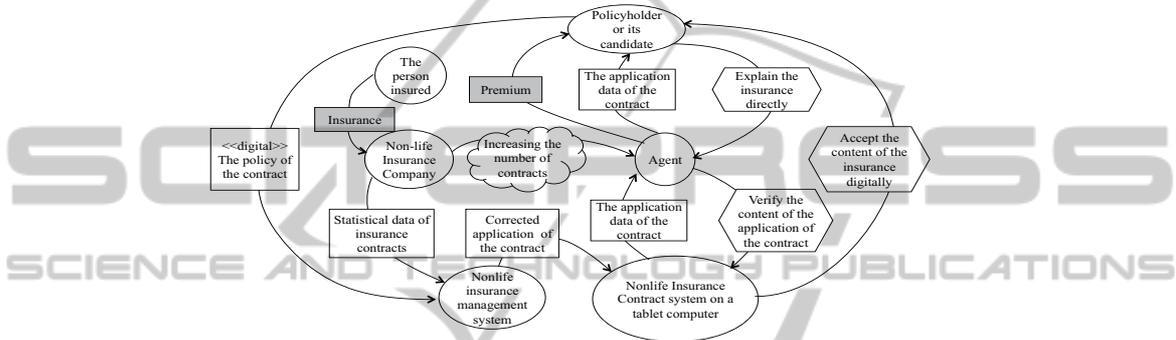


Figure 4: SD model of the expected to-be context of a contract of non-life insurance.

policies. Thus, the subcontractors who were the customers of the agents made requests to the agents to provide policy certificates in paper form. In order to understand the context of the change in requirements, we have to understand the environment with regard to the social relations that affect the intentions of stakeholders. The general contracts were in the context of the requirements of subcontractors who were indirect users of the NIC system, but the direct users of the outcomes of the system. The origins of changes in requirements are sometimes at a distance from stakeholders. The new requirements are shown in Figure 6 in colored icons.

Some of the agent companies refused to introduce the tablet computers, since the tablet computers would increase their costs with regard to facilities and communication expenses. The context of these refusals was out of the scope of the non-life insurance company. Figure 7 shows the situation. The extended SD model can visualize the context of the intention of stakeholders. How does the NIC system contribute to and increase the sales of the agent companies? Figure 4 did not mention the issue.

We analyzed the context of the actors shown in Figure 4 with an extended SD model. The missing point was that of the variations of the parties surrounding the actors. The agents were not only the users of the system but also employees of the agent companies,

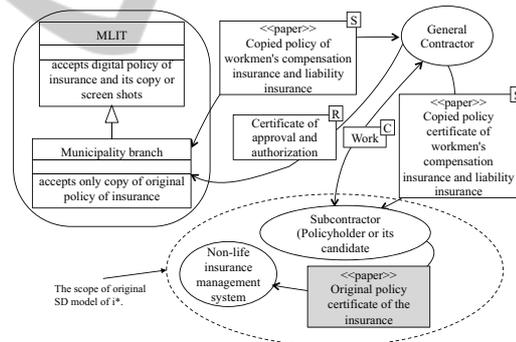


Figure 6: The analysis of the source of changes in the context of requirements.

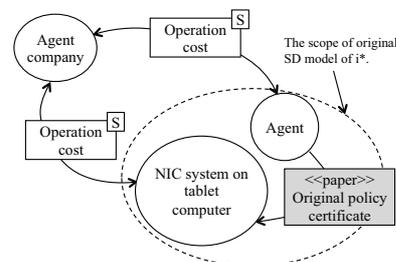


Figure 7: The context of the person in charge of the agency.

who were tasked with the pursuit of profit as well as the reduction of costs. Furthermore, there was a variation of the authorities of the Japanese government.

If analysts can visualize such variations, they might be able to get more precise information with regard to these variations, and thus, deal with the requirements changes.

4 DISCUSSION AND CONCLUSION

In this paper, we presented an analysis method of the context of stakeholders by extending the SD model of the i* framework. By applying the method to the software development project of the non-life insurance company, the model was able to visualize the sources. Within this context, there were present the sources of requirements changes that were out of scope in the original SD model. In the case study, we analyzed the context of stakeholders base on requirements changes. Although we did not predict the changes, we could get domain knowledge of the context of the stakeholders. In order to predict changes in requirements, analysts have to increase their knowledge of the domain and the context of the stakeholders. The study proved effective for those analysts. As a result of the case study, the analysts could realize the necessity of the analysis of the social environment of the agents and the visualization of the context of their requirements throughout the application of the extended SD model. We did not compare the positive and negative cost of the application of the method. Of course, the analyst who applies the method to his/her project is required more work than ever in the requirements analysis phase. However, we consider that the loss caused by the unexpected requirements changes is more expensive than the application of the method. We will evaluate the reliability of the consideration in our future work.

REFERENCES

- Alexander, I. and Robertson, S. (2004). Understanding project sociology by modelling stakeholders. *IEEE Software*, 21(1):23–27.
- Bano, M., Imtiaz, S., Ikram, N., Niazi, M., and Usman, M. (2012). Causes of requirement change—a systematic literature review. In *Evaluation and Assessment in Software Engineering*, pages 22–31. The institute of Engineering and Technology.
- Damas, C., Lambeau, B., and van Lamsweerde, A. (2006). Scenarios, goals, and state machines: a win-win partnership for model synthesis. In *SIGSOFT '06/FSE-14: the 14th ACM SIGSOFT international symposium on Foundations of software engineering*, pages 197–207. ACM.
- Ebert, C. and D., M. J. (2005). Requirements uncertainty: influencing factors and concrete improvements. In *The 27th International Conference on Software Engineering*, pages 553–560. IEEE.
- Faily, S. and Flechais, I. (2009). Context-sensitive requirements and risk management with iris. In *The 21st IEEE International Requirements Engineering Conference (RE'09)*, volume 0, pages 379–380, Los Alamitos, CA, USA. IEEE Computer Society.
- Fiske, A. P. (1992). The four elementary forms of sociality: Framework for a unified theory of social relations. *Psychological Review*, 99(4):689–723.
- Kotonya, G. and Sommerville, I. (1998). *Requirements Engineering: Processes and Techniques*. John Wiley & Sons.
- MacAulay, L. (1996). *Requirements Engineering*. Springer.
- Nakatani, T. and Tsumaki, T. (2014). Predicting requirements changes by focusing on the social relations. In *The 10th Asia-Pacific Conferences on Conceptual Modeling*, pages 65–70. Australian Computer Society.
- Nurmuliani, N., Zowghi, D., and Fowell, S. (2004). Analysis of requirements volatility during software development life cycle. In *The 2004 Australian Software Engineering Conference (ASWEC'04)*, pages 28–37.
- Pohl, K. (2010). *Requirements Engineering: Fundamentals, Principles, and Techniques*. Springer.
- Robertson, S. and Robertson, J. (2005). *Requirements-Led Project Management*. Addison-Wesley.
- Sommerville, I. and Sawyer, P. (1997). *Requirements Engineering-A good practice guide*. John Wiley & Sons.
- Sutcliffe, A., Feckas, S., and Sohlberg, M. M. (2005). Personal and contextual requirements engineering. In *The 13th International Requirements Engineering Conference (RE'05)*, pages 19–30. IEEE.
- van Lamsweerde, A. (2004). Goal-oriented requirements engineering: A roundtrip from research to practice. In *The 12th International Requirements Engineering Conference (RE'04)*, pages 4–7. IEEE.
- Williams, B. J., Carver, J., and Vaughn, R. (2006). Change risk assessment: Understanding risks involved in changing software requirements. In *The International Conference on Software Engineering Research and Practice (SERP 2006)*, pages 966–971.
- Yu, E., Giorgini, P., Maiden, N., and Mylopoulos, J., editors (2011). *Social Modeling for Requirements Engineering*. MIT Press.
- Yu, E. S. K. and Mylopoulos, J. (1998). An actor dependency model of organizational work –with application to business process reengineering. In *Conference on Organizational Computing Systems (COOCS'98)*, pages 258–268.
- Zowghi, D. and Nurmuliani, N. (2002). A study of the impact of requirements volatility on software project performance. In *Asia-Pacific Software Engineering Conference*, pages 3–11. IEEE.